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(54) **Paging signal control system in mobile communication system.**

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(73) Proprietor : **NIPPON TELEGRAPH AND TELEPHONE CORPORATION**
1-6 Uchisaiwaicho 1-chome
Chiyoda-ku
Tokyo (JP)
Proprietor : **NTT MOBILE COMMUNICATIONS NETWORK INC.**
10-1, Toranomon 2-chome
Minato-ku, Tokyo 105 (JP)

(72) Inventor : **Yamada, Tomoyuki**
4622-3, Kamariya-cho,
Kanazawa-ku
Yokohama-shi, Kanagawa (JP)
Inventor : **Onoe, Seizo**
9-2, Sugita,
Isogo-ku
Yokohama-shi, Kanagawa (JP)

(74) Representative : **Knoblauch, Andreas, Dr.-Ing. et al**
Kühhornshofweg 10
D-60320 Frankfurt (DE)

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Description

The invention relates to a paging system in a mobile communication system for service of mobile stations which include both a vehicle equipment and a portable equipment.

In a mobile communication system, the power consumption of a mobile station must be as small as possible so that a battery in the mobile station operates as long as possible. It should be noted that a mobile station consumes some power even in the waiting state.

Conventionally, an intermittent receive system has been used in a pocket bell system for reducing the power consumption as shown in JP patent laid open publication 60-52133 dated March 25, 1985, and in JP patent laid open publication 63-227134 dated September 21, 1988. In that system, mobile stations are classified into a plurality of groups so that each group includes a plurality of mobile stations. A Paging information is broadcast in a time slot which is specific to the related group, and a mobile station in the group receives the time slot signal. As the power consumption when the station does not receive the time slot is very small, the power is essentially supplied intermittently, and the charged time or the life time of the battery is long. In that system, a buffer memory is provided to store paging calls in each time slot, and the content of the memory is broadcast in the related time slot. A call originated when a related area of the buffer memory is full is handled as a call loss.

However, the conventional intermittent receive system has the disadvantage that the call loss depends much upon the call occurrence, and the call loss is large as compared with that in which no group classification is used.

If we intend to provide the same call loss as that with no group classification, the number of paging slots must be increased, but the increase of the paging slots decreases the efficiency of the paging slots or the paging channels.

Another disadvantage of the conventional intermittent receive system is that both the portable equipment which is carried by a person, and the vehicle equipment which is carried by a vehicle, are classified into groups, while the vehicle equipment has no serious necessity for power saving, or related problems.

It is the object, therefore, of the invention to provide a paging signal control system which is used in both a vehicle equipment and a portable equipment, reduces power consumption in the portable equipment, and provides high efficiency of the paging channels.

This object is attained by a paging signal control system having a plurality of mobile stations and one or more base stations coupled with a communication network and communicating via channels consisting of time slots, characterized by mobile stations being

classified into grouped stations which in the waiting state receive only time slots reserved for that group, and ungrouped stations which receive all the time slots in the waiting state; each mobile station and each base station having information whether the mobile station is a grouped station or an ungrouped station, and the group which the mobile station belongs to; a base station having a plurality of buffer cells, the content of each of which is broadcast in the related time slot of a paging channel; a paging signal to a grouped station being stored in the related buffer cell, and a paging signal to an ungrouped station being stored in the buffer cell which has the shortest queue; a grouped station receiving only a part of the time slots relating to the own station, and an ungrouped station receiving all the time slots.

The invention will now be described in more detail with reference to the drawings of preferred examples of embodiments, wherein

Fig.1 is a block diagram of a main portion of a base station for implementing a paging signal control system according to the invention,

Fig.2 is an embodiment of a signal format of a paging signal according to the invention,

Fig.3 is another embodiment of a signal format of a paging signal according to the invention,

Fig.4 shows curves of the call loss ratio of the invention and a prior art, and

Fig.5 shows a system diagram of a mobile communication system in which the invention is used.

In Fig. 5 the symbol BS shows a base station which is coupled with a mobile station MS through a radio channel. Each base station BS is coupled with a control station through a paging channel P-CH for a receive call to a mobile station MS, an access channel A-CH for originating a call from a mobile station MS, and a speech channel S-CH. The control station is coupled with a communication network. It is supposed that the control station has a home memory which stores information relating to each mobile station MS.

A mobile communication system has a speech channel for speech communication, a paging channel for paging control in a receive phase, and an access channel for access control.

According to Fig.1, which relates to a paging channel a buffer selector 1 selects one of the buffer cells 1 through n when the base station receives a paging signal 10 so that said paging signal is stored in the selected buffer cell. The signal format of a paging signal has a preamble P, a frame synchronization bit F, a paging signal indicator R, an identification of a mobile station ID, a group number S of a mobile station, a flag G/U showing whether the mobile station is a grouped station or an ungrouped station, and a check bit C. The flag G/U is 1 or 0. The group number S in the present embodiment is in the range from 1 to 5.

A mobile station analyzer 2 analyzes whether the mobile station to be paged is a grouped station or an ungrouped station, and when it is a grouped station the group or the time slot which the mobile station belongs to is provided. The paging signal 10 is used for the mobile station analysis. The information of the paging signal 10 which the mobile station analyzer 2 uses is stored in a home memory (not shown) in a mobile communication network. The analyzed result by the mobile station analyzer 2 is supplied to the buffer selector 1 for the selection operation.

When a mobile station to be paged is an ungrouped station, the paging signal is stored in the buffer cell which has the shortest queue in all the buffer cells. It is preferable that a table 1a is provided in a buffer selector 1, showing the length of the queue in each buffer cell. In the embodiment, the buffer cells 1-5 have the queue 0, 4, 6, 10 and 7. Therefore, the new paging signal for an ungrouped station is stored in the buffer cell 1 which has the shortest queue (length 0).

A mobile station may either belong to a fixed group, or a variable group depending upon a mobile visited area. In the latter case, the necessary information for the operation of the mobile station analyzer 2 is obtained by using ID (identification) of the mobile station, and a dictionary in a home memory (not shown).

The buffer cells 5 (buffer cell 1 through n) relate to each time slot of a paging channel. The outputs of the buffer cells 5 are multiplexed in the multiplexer 3 so that the information in each buffer cell is inserted in the related time slot. The multiplexed paging signal is transmitted through a transmitter 4 and an antenna 6.

When the content of a buffer cell has been transmitted, the related area of the table 1a will be reset to zero through a control line 3a from the multiplexer 3.

In the paging signal format shown in Fig.2. The paging slots 1 through n correspond to the buffer cells 1 through n in Fig.1. The paging signals stored in each buffer cell are transmitted in the related time slot on a first-in-first-out basis.

It is assumed that a portable station which is carried by a person is grouped. When a paging signal to the grouped portable station is received by the base station, the mobile station analyzer 2 advises the buffer selector 1 the buffer cell which the portable station belongs to, and the paging signal thus received is stored in the buffer cell which the portable station relates to. When the buffer cell is full, the new paging signal is handled as a call loss. The content of the buffer cell is broadcast as mentioned above.

A portable station which is carried by a person receives intermittently the paging channel so that only the time slot related to the own portable station is received. When the portable station belongs to the group 6, the receive operation is carried out during the time slot 6 as shown in Fig.2. It should be appreciated

that the time slot 6 in which the portable station operates is considerably short, and the power consumption when the station does not receive is very small. Therefore, the power consumption in a portable station is small, and the battery of the portable station operates longer.

It is assumed that a vehicle station which is carried by a vehicle, or a fixed station is an ungrouped station. When a paging signal to the vehicle station reaches the base station, the mobile station analyzer 2 recognizes that the station is not grouped, and advises the buffer selector 1 that the station is an ungrouped station. The buffer selector 1 selects one of the buffer cells so that the queue in the selected buffer cell is the shortest in all the buffer cells. When all the buffer cells are full, the receive call is handled as a call loss.

As a modification, the condition of a call loss to a vehicle station call is designed adaptively so that a call loss in a grouped station is equal to that of an ungrouped station. For instance, a paging signal is handled as a call loss when the queue in the buffer cell which has the shortest queue is larger than a predetermined value, or when the number of buffer cells which have the queue shorter than the predetermined value is smaller than a predetermined value.

Further, it may be possible to move a paging signal from a vehicle station from a first buffer cell to another buffer cell when the queue in each buffer cell changes during the stay of the paging signal in the first buffer cell. In that case, no movement of the paging signal is effected when the queue in the second buffer cell is larger than a predetermined value so that the wait time of the paging signal does not exceed a predetermined value.

A vehicle station receives constantly paging signals as shown in Fig.2(c). As the vehicle station has a large battery, no consideration for power saving is necessary.

Fig.3 shows a modification of a paging channel according to the present invention, in which it is supposed that a plurality of paging channels 1 through 3 are provided. The use of a plurality of paging channels is useful when the number of subscribers is increased. When the number of subscribers is small, a single paging channel is used, and when the number of subscribers increases, the number of paging channels is also increased. Fig.3 shows the embodiment that there are three paging channels. In that case, a portable station which belongs to, for instance, group 10, receives only the time slot 10 in the first paging channel. On the other hand, a vehicle station is classified based upon the paging channels. When the vehicle station belongs to the first paging channel, it receives the first paging channel which includes the time slots 1, 4, 7, 10, 13, et al. Similarly, another vehicle station which belongs to the second paging channel receives the time slots 2, 5, 8, 11, 14, 17 et

al. Thus, it should be appreciated that vehicle stations are grouped in a different manner from classification of portable stations.

The invention has the effect that the call loss ratio depends less upon the dispersion of occurrence interval of a call, as compared with the prior art which groups all the mobile stations. As the vehicle equipment receives all the slots, and the portable equipment receives only the related slot, the ratio of the receive slot to all the time slots is the same as that of the prior art. Therefore, the invention can reduce the power consumption of a portable station while keeping traffic intensity for each slot large, and keeping waiting time and call loss ratio constant.

Fig.4 shows the simulation curves of the invention, in which portable stations are classified into 20 groups, the vehicle stations occupy 75 % of all the mobile stations, and the number of buffer cells is 5. The horizontal axis in Fig.4 shows the traffic amount, and the vertical axis shows the call loss ratio. The solid curve shows the characteristics of the invention, and the dotted curve shows the characteristics of the prior art.

It should be appreciated in Fig.4 that the traffic amount for the predetermined call loss ratio of the invention is larger than that of the prior art. For instance, when the call loss ratio is 10^{-3} , the traffic amount of the invention is 1.5 times as large as the prior art. It should be appreciated that the large traffic amount means that a large number of mobile stations may be occupied in a predetermined number of receive time slots, and/or the number of control channels may be reduced.

Therefore, the present invention may reduce the power consumption of a portable equipment, while increasing the efficiency of a control channel under the predetermined traffic condition and communication quality.

Claims

1. A paging control system in a mobile communication system having a plurality of mobile stations (MS) and one or more base stations (BS) coupled with a communication network and communicating via channels consisting of time slots, characterized in that the mobile stations (MS) are classified into grouped stations which in the waiting state receive only time slots reserved for that group and ungrouped stations which receive all the time slots in the waiting state, each mobile station (MS) and each base station (BS) have informations whether the mobile station is a grouped station or an ungrouped station, and the group which the mobile station belongs to, a base station (BS) has a plurality of buffer cells (5), the content of each of which is broadcast in the relat-

ed time slot of a paging channel (P-CH), a paging signal (10) to a grouped station is stored in the related buffer cell (5), and a paging signal (10) to an ungrouped station is stored in the buffer cell (5) which has the shortest queue, a grouped station receiving only a part of the time slots relating to the own station, and an ungrouped station receiving all the time slots.

2. The paging control system according to claim 1, characterized in that an ungrouped station receives all the time slots of one of the paging channels (P-CH).
3. The paging system according to claim 1, characterized in that a base station has a table (1a) storing the length of queue in each buffer cell (5).

Patentansprüche

1. Ruf-Steuersystem in einem mobilen Kommunikationssystem mit einer Vielzahl mobiler Stationen (MS) und einer oder mehreren Basisstationen (BS), die mit einem Kommunikationsnetz verbunden sind und über Kanäle, die aus Zeitschlitzten bestehen, kommunizieren, dadurch gekennzeichnet, daß die mobilen Stationen (MS) in gruppierte Stationen, die im Wartezustand nur für diese Gruppe reservierte Zeitschlitzte empfangen, und in ungruppierte Stationen unterteilt sind, die alle Zeitschlitzte im Wartezustand empfangen, jede mobile Station (MS) und jede Basisstation Informationen darüber, ob die mobile Station eine gruppierte Station oder eine ungruppierte Station ist, und die Gruppe enthalten, zu der die mobile Station gehört; eine Basisstation (BS) eine Vielzahl von Pufferzellen (5) hat, der Inhalt jeder Pufferzelle in dem zugehörigen Zeitschlitz eines Rufkanals (P-CH) ausgesendet, ein an eine gruppierte Station ausgesendetes Rufsignal (10) in der zugehörigen Pufferzelle (5) gespeichert und ein an eine ungruppierte Station ausgesendetes Rufsignal (10) in der Pufferzelle (5) gespeichert wird, die die kürzeste Warteschlange aufweist, wobei eine gruppierte Station nur einen Teil der Zeitschlitzte empfängt, die zu der eigenen Station gehören, und eine ungruppierte Station alle Zeitschlitzte empfängt.
2. Ruf-Steuersystem nach Anspruch 1, dadurch gekennzeichnet, daß eine ungruppierte Station alle Zeitschlitzte eines der Rufkanäle (P-CH) empfängt.
3. Ruf-Steuersystem nach Anspruch 1, dadurch gekennzeichnet, daß eine Basisstation eine Tabelle (1a) hat, in der die Länge der Warteschlange bei

jeder Pufferzelle (5) gespeichert ist.

Revendications

1. Système de commande de signal d'appel dans un système de communication mobile comportant plusieurs stations mobiles (MS) et une ou plusieurs stations de base (BS) raccordées à un réseau de communication et communiquant par l'intermédiaire de canaux constitués par des intervalles ou sections de temps, caractérisé en ce que les stations mobiles (MS) sont classées en stations groupées qui dans l'état d'attente ne reçoivent que les intervalles ou secteurs de temps réservés pour ce groupe et des stations non groupées qui reçoivent continuellement les intervalles ou secteurs de temps dans l'état d'attente, chaque station mobile (MS) et chaque station de base (BS) comportant des informations pour savoir si la station mobile est une station groupée ou une station non groupée, et le groupe auquel appartient la station mobile, une station de base (BS) comporte plusieurs cellules tampons (5), le contenu de chacune d'entre elles étant diffusé dans l'intervalle ou secteur de temps concerné d'un canal de signal d'appel (P-CH), un signal d'appel (10) destiné à une station groupée est mémorisé dans la cellule tampon concernée (5), et un signal d'appel (10) destiné à une station non groupée est mémorisé dans la cellule tampon (5) qui possède la file d'attente la plus courte, une station groupée ne recevant qu'une partie des intervalles ou secteurs de temps concernant sa propre station, et une station non groupée recevant tous les intervalles ou secteurs de temps.
2. Système de commande de signal d'appel selon la revendication 1, caractérisé en ce qu'une station non groupée reçoit continuellement les intervalles ou secteurs de temps des canaux de signaux d'appel (P-CH).
3. Système de signal d'appel selon la revendication 1, caractérisé en ce qu'une station de base comporte une table (1a) mémorisant la longueur de file d'attente dans chaque cellule tampon (5).

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Fig. 1

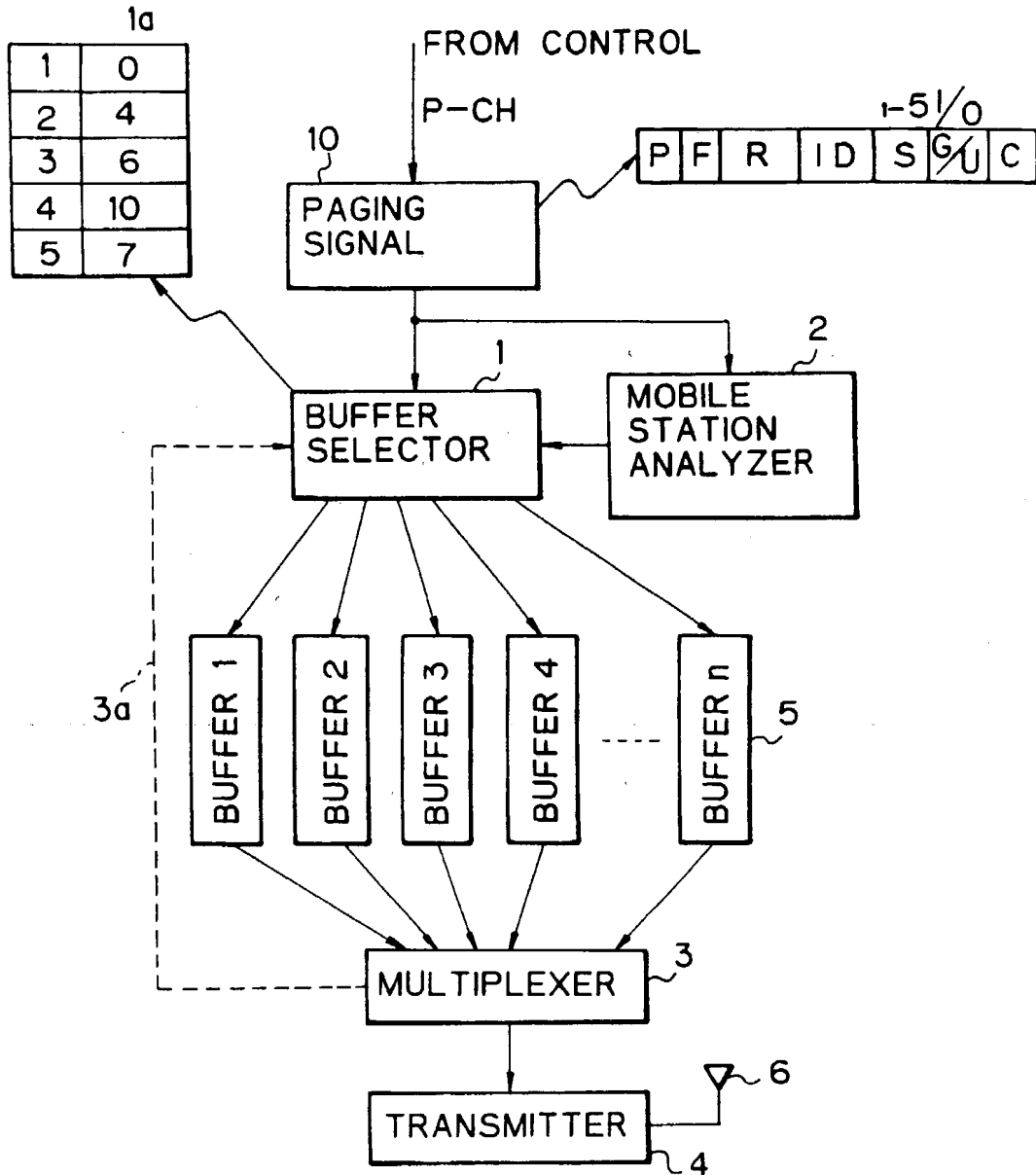


Fig. 2

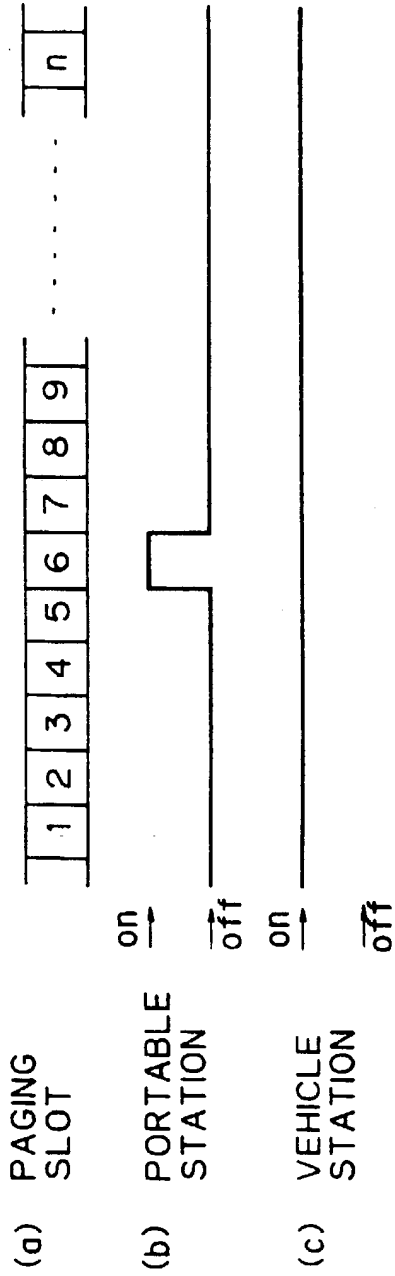


Fig. 3

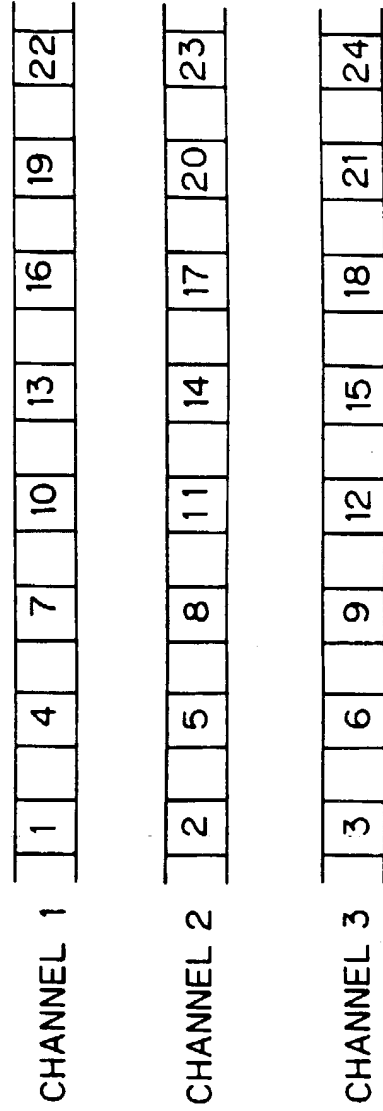


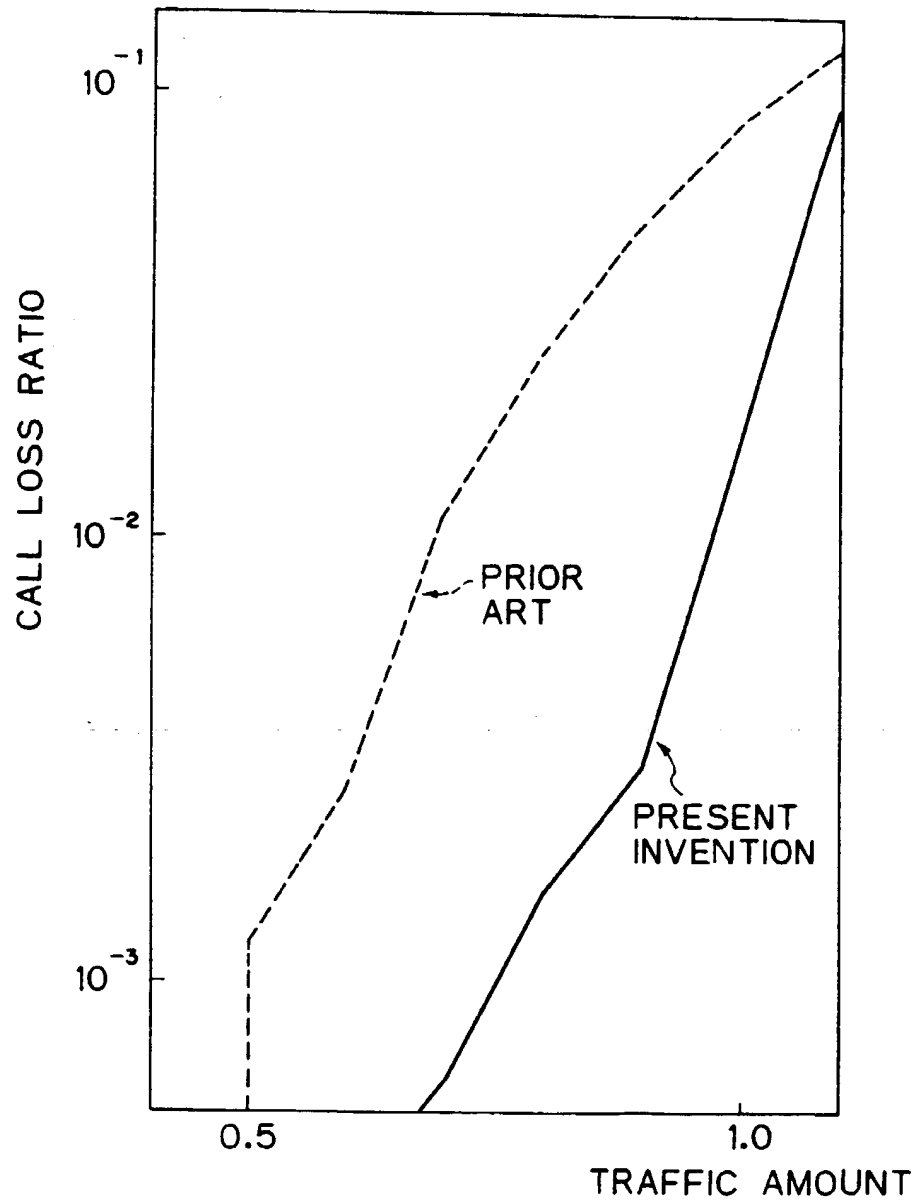
Fig. 4

Fig. 5

